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# Comforting Agents

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**Introduction**

The ability for computer agents to provide comfort to users has important applications in healthcare and other areas. Automated systems that comfort users could be used in pain management, palliative care, and pre-surgery anxiety reduction. In addition to the potential health applications of such systems, simply alleviating transitory negative affect in users may have beneficial effects on attention, memory retention, learning, creativity, and attitude towards the perceived source of the affective state [13].

Systems that effectively comfort users require many features that make them supple, including subtle inputs for affect sensing, long-term establishment and maintenance of a trusting relationship with the user, and dynamic tailoring of comforting strategy and content based on detailed knowledge of the user and the interaction context.

Studies have shown that effective comforting messages are those which explicitly acknowledge and validate the recipient's emotional state. Furthermore, the most effective messages offer a cognitively-oriented explanation of the recipient's emotions, and help to relate those emotions to a broader context [7]. It has been theorized that such messages facilitate emotional change via a cognitive reappraisal process [8]. This process is grounded in a theory of cognitive appraisal

[14], which posits that specific emotions arise from an appraisal of events – what they mean to one’s personal well-being. Comforting messages may ameliorate emotional states by prompting a change in these appraisals. Constructing effective comforting messages will therefore require, at a minimum, knowledge of the user’s emotional state. In order to explain the user’s emotions and relate them to a broader context, the agent must also have knowledge of the user’s goals and desires, and of the events which precipitated the user’s emotions.

Strategies for producing comforting messages will also require a complex exchange of information with the recipient. An agent must interpret subtle cues to detect the user’s emotion, and may use techniques such as affect sensing, or input methods that allow the user to explicitly indicate their emotions (such as the use of emoticons, or kinesthetic input). Gathering additional knowledge may involve the use of language, and multiple turns of conversations.

Another aspect of comforting messages between humans is that they typically occur in the context of a relationship. Indeed, emotional support (including comforting behavior) is one of the key provisions of a friendship [10]. Agents that have and maintain a relationship of trust with a user may deliver more effective comfort. Thus, “relational agents” — those designed to establish social bonds with users [2] — should be particularly important for comforting. In previous work, we have demonstrated the ability of a relational agent to establish a working alliance relationship with users over multiple interactions, partly through use of empathic and comforting behavior [1,2].

## **Related Work**

Work on comforting agents was pioneered by Klein in 1999. The CASPER affect-management agent used active listening techniques (displays of empathy) via text menus, and was shown to be significantly more effective at alleviating computer users’ frustration compared with identical systems that only allowed users to express their feelings (vent) or ignored their feelings altogether [13].

Brave, et al, demonstrated that computer agents that manifest “other-oriented” emotions (e.g., empathy) led to more positive ratings of the agent by users, including greater perceived caring and felt support, compared to agents that either did not display any emotions or only displayed “self-oriented” emotions [6].

Bickmore and Picard demonstrated that a relational agent that used a range of relationship-building behaviors in daily interactions with users over time was able to establish a greater sense of being cared for in users compared to the same agent that did not use these behaviors [3].

Hone conducted a series of experiments in which she first replicated Klein’s results, then found that embodied agents were more effective at reducing computer user frustration than non-embodied agents, and that female embodied agents were more effective at comforting than male embodied agents [11].

## **Ongoing Work in Comforting Agents**

We have conducted two of a planned series of studies on the ability of relational agents to calm and comfort users. In these studies we use a standard mood induction technique to increase anxiety in study

participants. Changes in anxiety level are measured through self report and physiological measures (heart rate and galvanic skin response).

In our first study, we attempted to show that the mere presence of a relational agent that the user had previously bonded with would lead to significant decreases in anxiety [4]. This work was based on several studies that showed that the mere presence of a human friend or significant other, or even the presence of a pet, would lead to reductions in cardiovascular reactivity when study subjects were confronted with cognitive stressors [9,12].



**Figure 1.** Experimental setup for our most recent study

In our most recent study, we evaluated whether it is better to restrict what users can say about how they are feeling so that the agent can unambiguously determine their emotional state and provide accurate comforting (low expressivity and high empathic accuracy), or rather to allow users to express their feelings in an unconstrained manner, despite the

likelihood that the agent's inferences about their emotional state will often be incorrect (high expressivity and low empathic accuracy). We found that empathic accuracy was more important (and more liked) than user expressivity in comforting interactions [5].

### **Future Work in Comforting Agents**

We have additional experiments planned to explore the ability of relational agents to calm and comfort users. One set of experiments will evaluate the efficacy of multiple interaction modalities in comforting agents, including touch screen and speech recognition for the user input and haptics for the agent output. We also plan to develop a text generation system that can effectively produce comforting messages of varying quality (according to Burleson's taxonomy of comforting messages [7]) and evaluate the effect of these on calming users. Ultimately, we are interested in using comforting agents both in counseling systems, in which comforting is used to establish higher quality, long-term working alliance relationships between users and agents, and in healthcare applications in which patients are in extreme distress, such as pain management, labor and delivery and palliative care.

### **Conclusion**

Many of the features of supple interfaces are required for effective comforting of users. Subtle signals must be interpreted for affect sensing. An agent should dynamically tailor strategy and content based on detailed knowledge of the user and the interaction context, and seek the long-term establishment and maintenance of a trusting relationship with the user. Such comforting agents have broad applicability in

healthcare and HCI and therefore represent an important area for development and investigation.

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